expansion. It therefore comes to that particular temperature at which it can lose heat by radiation at exactly the same rate that it gains heat by absorption. From this level up the intensity of the radiation from the earth and atmosphere below is practically independent of height. That is why temperature up there also is independent of height. It doesn't change appreciably even from day to night, and so we infer that it is not much affected by sunshine directly.

Thus again we had come to that state of mental ease that goeth with understanding. But the ease was of short duration. It soon was found that the upper air, the stratosphere, as scientists now call it, is coldest over equatorial regions and becomes gradually warmer with increase of latitude, the extreme difference being around 35° F.—coldest over the warmest earth and warmest over the coldest earth. Here was a poser, and we are not through trying to explain it yet. And now they (certain scientists) tell us that up beyond the highest reach of our balloons there is ozone in the very thin air. Well, that is what we would expect from the fact that ozone is produced whenever a certain portion of ultra-violet radiation falls on oxygen. But botheration again! There seems to be least ozone over tropical regions, where we would expect most, and more and more with increase of distance from the equator, and not less and less. Well, this isn't explained yet either, but we can make use of it, and that is what we propose now to do.

Ozone is a powerful absorber of the long wave-length radiation that goes out from the earth and its water-soaked atmosphere. Furthermore, whatever quantity of radiation the ozone absorbs, that same quantity, changed in part to other wave lengths, it must reradiate, otherwise it clearly would do what obviously it is not doing, that is, continuously get either warmer or colder. Now, as the radiation by the ozone evidently is as much in one direction as another, half of it is back towards the lower atmosphere. It also is evident that where there is least ozone the percentage of absorption and reradiation also is least, and as the quantity of the ozone increases so also does this percentage of return radiation. In short, one reason (not the only one) why the stratosphere becomes colder and colder as we go from high latitudes to the Equator, is because the ozone blanket at the same time grows thinner. It is a little like sleeping warmly outdoors under a quilt or shivering under a sheet—lots depends on the kind and quantity of covering one has.

ICE STORM OF DECEMBER 17–18, 1929, AT BUFFALO, N. Y.

551.578.4 (747)

By J. H. SPENCER, Weather Bureau

On the morning weather map of December 17, 1929, pressure was high along the Canadian border and to the northward, while a moderate LOW extended from the southern part of the upper Lake region southwestwardly to Oklahoma and northern Texas. Light north to east winds resulted in the Lake region. The striking feature on the weather map of this date was the fact that moderate to heavy rains were falling over the southern half of the Lake region, with temperature below the freezing point at the surface. The temperature at 8 a. m. at Buffalo, for instance, was 26°, rain falling at the time. Rain continued throughout the day and most of the night, exceeding an inch.

Part of the heavy rain at Buffalo froze as it fell, or soon after, making streets and sidewalks very slippery and dangerous, but sloppy above the ice in many sections. Practically all the time that rain fell the temperature was below freezing. The resulting ice storm of Tuesday and Tuesday night, December 17, was one of the worst of record here. Hundreds of street trees were severely damaged. The weight of the ice Tuesday night was at least double that which resulted from the ice storm of December 7 and 8. Tree branches the size of an ordinary lead pencil were enlarged by the ice to the thickness of 1 to 1½ inches. Thousands of limbs as large as one's arm were broken off by the weight of the ice, great damage resulting.

ICE ON BRANCHES

Forsythia branch.—Length, 1 yard 4 inches. No lateral twigs. Total weight, with ice, 1⅛ pounds; without ice, ⅜ ounce. Greatest diameter of ice, 1¼ inch to full 1½ inch. Slightly uneven, due to buds at 2 to 3 inch intervals. Top diameter of ice was 1 inch and narrowing to a knife blade at bottom. (See fig. 1.)

Thickness of ice above wood, about ⅞ inch; below wood, ¼ to ⅜ inch. Weight of wood, ⅜ ounce. Diameter of wood alone, ⅛ inch at small end and ¼ inch at large end. Ice coating was as thick at one end as at the other.

Elm branches.—From one large limb lying on the street I broke off four tips, each about 15 inches long, and with lateral twigs, without disturbing the ice. Collectively they weighed, with ice, 2½ pounds; without ice, 3 ounces.

One ornamental tree in my yard, as large as a full-grown fruit tree, was completely broken down. I broke off a tip 28 inches long, with lateral twigs, from one branch; weight, with ice, 1½ pounds; without ice, 1 ounce. It was impossible to see between the icy branches of this tree; that is, one could not see the street or any object on the other side of the tree, so heavy was the ice on the limbs.

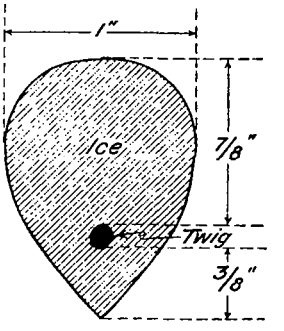

FIGURE 1

After these measurements were made, I brought the ice-covered branches into a warm room, with temperature of 70°, and it took more than two hours for the ice to melt away sufficiently for it to break away from the wood. This illustrates roughly how difficult it is in a cold climate to get rid of the ice before it does great damage merely by remaining on objects for many hours and often days after the ice storm occurs.

AFTER THE ICE STORM

Cold weather, with temperature below freezing, and without sunshine, continued through December 18, 19, and 20. Ice remained as heavy on trees and wires as on the night of the 17th and 18th. On the 19th there was more than an inch of sleet (very small ice pellets that looked, in the aggregate, like snow, but of great weight). Following this, a 50-mile gale blew most of the time for 24 hours, beginning soon after 8 a. m. of the 20th; and on the night of the 20th and 21st there was a 6-inch fall of snow, which drifted badly. These long-continued severe conditions caused great damage and much hardship in the Buffalo district and throughout western New York.

To combat the situation many hundreds of linesmen were brought in from distant cities to repair the damage on telephone and telegraph lines; traction companies operated with difficulty; some bus lines were unable to operate at all; electric light service was interrupted, failing entirely in many sections; hundreds of automobiles were stalled along the highways; railroad trains ran hours late; all the principal radio stations were unable to operate; large numbers of aerials were down; "Christmas shopping" was interfered with; and numerous injuries and several deaths were attributed to the storms. Rarely indeed has this section been visited by such a procession of severe storms.

Most of the great damage to trees occurred on the night of the 17th and 18th, during a comparative calm; while the greater part of the damage to telephone and telegraph lines followed that date, particularly during the gale on the day of the 20th and night of the 20th and 21st. Damage from all these conditions will be between one and a half to two millions or more; but no one will know for several weeks to come. I think the above is a conservative estimate.

OUTSTANDING FEATURES

Almost incredible quantities of ice accumulated on trees, shrubbery, and other objects. (See special reference thereto.) The streets and boulevards of Buffalo were so badly cluttered up with broken-off branches after the storm that an appropriation of $50,000 was asked for to clean up the city. It will cost I believe, several times that amount to replace trees and trim up those that can be saved. I have seen in other parts of the country damage to telephone and telegraph lines quite as severe as occurred here, but never anything like the damage to trees. All night long of the 17th and 18th one was kept awake by the breaking limbs, which snapped off with a report much louder than a rifle shot. It was a depressing and never-to-be-forgotten experience. Otherwise the night was quiet, there being very little wind.

In 35 years' experience I have never seen Weather Bureau instruments so completely frozen up. The vane and anemometer were heavily caked with ice and put out of commission both at the downtown office and the airport. There was a mass of ice more than 2 inches thick on one side of the sunshine recorder.

The losses mount up, as the work of restoration progresses. I think this is approximately correct:

Total losses in western New York, including the Buffalo and Rochester districts, were around $3,000,000, perhaps more. More than 8,000 telephone poles were carried down by the sleet and wind, with approximately 15,000 miles of wire. The telephone companies alone sustained a loss of approximately $2,000,000.

HAILSTORMS OF 1929 IN THE UNITED STATES

By S. D. FLORA

[Weather Bureau office, Topeka, Kans.]

[Condensed from a report by the author]

Hail damage was severe and widespread during 1929 but not as bad as in 1928, which was one of the worst, if not the worst, hail years in the history of the country. While the total loss by hail for 1929, like that of previous years, will probably never be known definitely, the United States Weather Bureau received reports of more than 225 severe hailstorms during the year with property losses exceeding $10,000,000. The total losses will greatly exceed these estimates from outstanding storms as there were hundreds, possibly thousands, of falls of light or moderate hail, most of them doing but little damage for which no statistics are available.

One of the best indexes of hail damage over the country is the Iowa record, which is compiled from reports collected by the assessors, making that State the only one, so far as known, that knows the amount of its hail loss. This is given in the following table:

Hail damage in Iowa

1923	$2,319,506
1924	6,703,838
1925	7,975,691
1926	2,342,187
1927	5,064,717
1928	6,363,922
1929	[1] 2,354,551

[1] The 1929 figures are estimated from losses paid by insurance companies in Iowa, which were 37 per cent of the losses of the previous year.

There are probably several mid-western States that, if complete records were available, would show as great or even greater loss than Iowa. In Kansas hail losses actually paid by insurance companies in recent years have averaged close to two-thirds the Iowa totals, which include uninsured as well as insured crops, and it is known that a very large per cent of hail losses in Kansas are not covered by insurance. In 1929 hail losses of outstanding storms in Kansas, as reported to the Weather Bureau, totalled $2,403,500, with hundreds of smaller losses not reported.

Hail is always a special menace in Kansas on account of the immense wheat crop of the State, which approaches maturity during the season when hailstorms are most likely to occur. In the western third of the State Weather Bureau records indicate that heavy hail falls three to four times a year somewhere in each 10,000 square miles of area.

Thirty-eight heavy falls of hail were reported in Kansas last year and 15 of these occurred in June, with the wheat crop almost ready for harvest. Even so, the State was more fortunate than in 1928, when it suffered losses of a million dollars or more from each of six hailstorms. Ten of the 1929 Kansas hailstorms caused losses of $100,000 or greater each and one that extended from Byers to near Sawyer, diagonally across Pratt County, on June 13, resulted in a half-million-dollar loss. The path was 1 to 4 miles wide and 30 miles long. Wheat in the area was damaged 20 to 50 per cent.

Two days previous to the Pratt County storm hail fell over a path 60 miles long in Rawlins, Decatur, and Norton Counties, in northwestern Kansas, and almost totally destroyed wheat in some places. The worst of this storm was felt at New Alemelo, Norton County. The total damage was placed at $300,000.

Another of the Kansas hailstorms moved from near Newton to Cassoday, Butler County, on June 12, with the heaviest damage near DeGraff, Cassoday, McLain, and Potwin. The total loss was valued at $150,000. Along the path of severest hail wheat was a complete loss and the oats destroyed in some places. The grain was hammered into the ground until in some fields not a stem was left standing. Chickens, ducks, and geese, as well as birds, pigeons, and jack rabbits, perished literally by the hundreds.